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AUTHOR Hanes, Carol E.; Jordan, K. Forbis
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ABSTRACT

Since 1968 educational productivity studies at the University of Florida have been analyzing data from six States and one city. Linear regression was used to identify high and low productive units by measuring the relationship between statistically selected input factors and a measure of student achievement. Discriminant analysis was employed to determine which of several input variables were significantly associated with the classification. The design represents a refinement of efforts to determine the relative importance of factors subject to administrative control in effecting high student achievement. From their analysis, the authors concluded that, of those conditions subject to control by local school district administrators, teacher-related variables constitute the most important group of factors associated with educational achievement. (Author)

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FACTORS PREDICTING EDUCATIONAL PRODUCTIVITY

Carol E. Hanes, Virginia State Department of Education

&

K. Forbis Jordan, University of Florida

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Since 1968 educational productivity studies analyzing data from six states and one city have been performed at the University of Florida by using the following basic research design:

(1) Linear regression was used to identify high and low productive units by measuring the relationship between statistically selected input factors and a measure of student achievement.

(2) Discriminant analysis was employed to determine which of several input variables were significantly associated with the classification.

The design represents a further refinement in the efforts to determine the relative importance of factors subject to administrative control in effecting high student achievement.

The principal conclusion to be drawn from this research is that, of those conditions which are subject to the control of local school district administrators, teacher-related variables constitute the single most important group of factors associated with educational achievement.

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FACTORS PREDICTING EDUCATIONAL PRODUCTIVITY

Introduction

A major question confronting education is the identification of the factors associated with educational productivity. During the just-completed second phase of the National Educational Finance Project a series of seven studies was conducted that attempted to identify factors associated with educational productivity. This paper reviews the studies in terms of their common methodology and findings and draws some conclusions about the importance of these findings for administrative decisionmaking.

Theoretical Framework

As the concept of publicly supported free education has come to be accepted and implemented during this century, research efforts have been conducted to provide basic data required to develop a theoretical framework for the allocation of fiscal resources for education. These research efforts can be grouped into two large categories: studies of cost-quality relationships and educational productivity studies.

During the first half of the century additional funds were provided for educational programs based on the assumption that increased expenditures for education, by their very nature, would result in educational experiences of increased quality. This public policy position was supported by numerous empirical studies of the cost-quality relationship made by leading researchers and professors in

school administration.[1] Until the 1950s the educational expenditure studies were designed to show the relationship between the level of expenditure and the "character" of the program provided, that is, the provision of a school term of adequate length, instructional materials and libraries, and administrative personnel to manage the expanded programs.

The second phase of development of a theoretical framework began with the use of statistical analyses relating various system inputs with system products. First applied to industrial production following World War II, the theory of production function analysis assumes a known relationship among input resources. In applying this technique to education, substantial adjustment must be made, for not only are the critical factors of the learning experience largely unspecified, but also the nature of the interactions among in-school factors and socioeconomic factors are as yet undetermined. Many educational production research studies have used the simple linear regression function model that specifies one outcome and a series of input variables. Because this method has characteristics that are not particularly useful in explaining the educational process, alternative procedures have been under investigation. The series of studies reported in this paper employ a procedural refinement of this basic approach.

Method

In each study in this series the basic research design outlined below was used to identify school and nonschool variables that would differentiate between high and low productive school units.

In six studies data from a total of eight states were used; in the seventh study data were from individual schools in a large urban school district. The following two major steps were used:

1. Linear regression was used to identify high and low productive districts.
2. Discriminant analysis was employed to determine which of several input variables were most closely associated with the classification of districts as high or low productive units.

To identify high and low productive districts, a criterion variable was related to one or more independent variables, determining a regression line which predicted the level of the criterion variable to be expected for a given level of the independent variables. The size of the residual value was then used to identify high (a positive residual) and low (a negative residual) productive districts.

In the second step district membership in either the high or low group was predicted using discriminant analysis, and by this means a linear combination of these predictor variables that showed large differences in group means was derived. Variables postulated as having an association with productivity were analyzed to determine their relative relationship.

Results of the Studies

In a study using Florida data, Cage and Blekking used average scores for ninth-graders (1970) on the School & College Aptitude Test - Total in the sixty-seven school districts of the state as

the criterion variable.[2] Two variables, adult education level of the school district and percent nonwhite students in grades K-12, were regressed against the achievement scores to obtain predicted achievement levels. Residuals of more or less than 1/2 standard deviation from the regression line were used to identify high and low productive units, thereby classifying approximately one-third of the districts in the high group and one-third in the low group.

The following three variables were found to be significant contributors to the differences between high and low productive groups:

1. Percent of students attending some type of post-secondary educational institution.
2. Percent of teachers with two or fewer years of experience.
3. Percent of teachers with seven to fourteen years of experience.

A second study using Delaware data was made by Rose in 1972.[3] In that study per pupil expenditures for total current expenses (including expenditures for administration, instruction, plant operation and maintenance, auxiliary services, and fixed charges) for 1969-70 were regressed against the median district score achieved by fifth-graders on the Metropolitan Achievement Test in 1970. Ten of the twenty-two districts were identified as high productive and twelve as low productive.

Discriminant analysis was applied to two groups of variables--(1) the total group of socioeconomic and inschool variables, and (2) the inschool variables alone.

The following six variables were present in the maximal predictive function from the larger, composite group:

1. Adult education level.
2. Percent enrollment eligible for ESEA Title I Programs.
3. Average years of experience of teachers.
4. Percent minority pupils enrolled.
5. Salary of beginning teachers.
6. Percent teachers with advanced degrees.

All of the districts were correctly classified by this function.

Three of the inschool variables had maximum predictive value in classifying districts, correctly grouping 91 percent of the districts:

1. Percent of teachers with fewer than four years of professional preparation.
2. Average class size.
3. Salary of beginning teachers.

A third study was made using data for Kentucky.[4] High and low productive districts were identified by relating the mean reading equivalents of fourth-graders on the California Achievement Test Battery (1970) and 1970-71 current expenses per pupil, excluding transportation. Fourteen of the thirty-eight districts in the population were classified in the high group and twenty-four in the low group. In a discriminant analysis considering socioeconomic and inschool variables together, four variables emerged as maximally predictive:

1. Percent ESEA Title I pupils.
2. Expenses per ADA for transportation.
3. Average salary of teachers.

4. Expenses per ADA for instruction.

The composite of these four variables correctly classified 84 percent of the districts.

When inschool variables were analyzed alone, only the percent of teachers with advanced degrees was necessary to provide correct classification for 70 percent of the districts.

A fourth study used 1969-70 current expenditures per pupil in average daily membership and median composite achievement test scores of fourth-graders (1970) to select high and low productive elementary schools in a large urban school district.[5] Fifteen schools were thus classified into each productivity group. Six discriminant functions were analyzed, and the results are charted in Table 1.

DeRuzzo analyzed data from two states in his 1972 study.[6] Current expenditures per pupil in average daily membership (1968-69) were used as the independent variable in each state. In State A the district mean reading grade equivalent for eighth-graders on the California Achievement Test was used as the dependent variable; the district median raw score of the sixth-graders on the Stanford Reading Test was used for State B. Districts falling at least one standard deviation above or below the regression line were identified as high and low productivity districts, respectively. Sixteen districts were classified as high productive districts in State A, and ninety-three were placed in this category in State B. In State A sixteen districts fell into the low group; ninety-seven districts in State B were in the low productive group. Four discriminant functions were developed for each state, and the results of these are shown in Table 2.

TABLE 1

MAXIMAL DISCRIMINANT FUNCTIONS FOR DAEUFER'S STUDY

	Percent Accurate Classification
All Variables	
Percent Pupils from Low-income Families Percent Total Current Expenditures from Federal Sources Percent Certified Staff Without a Degree Mean Score on Survey of Teacher Morale	100
Student Characteristics Variables	
Percent Pupils from Low-income Families Percent Affirmative Responses on Surveyed Student Valence Toward School	93
School-Related Characteristics	
Percent Nonwhite Professional Staff Percent Certified Staff Without a Degree Mean Years of Teaching Experience of Staff Percent Total Current Expenditures for Instructional Salaries Percent Male Teachers	90
Nonschool-Related Characteristics	
Percent Pupils from Low-income Families Percent Attendance Percent Nonwhite Pupils Percent Voters "For" School Tax Levy	100

TABLE 1 (Continued)

	Percent Accurate Classification
Administrative Decisionmaking Variables	100
Percent Pupils from Low-income Families	
Percent Total Current Expenses from Federal Sources	
Percent Certified Staff Without a Degree	
Mean Score on Survey of Teacher Morale	
Administrative Nondecisionmaking Variables	97
Percent of Attendance	
Percent of Pupils from Families with Income Over $10,000	

TABLE 2

MAXIMAL DISCRIMINANT FUNCTIONS, DeRUZZO'S STUDY (1972)

STATE A	Percent Accurate Classification	STATE B	Percent Accurate Classification
All Variables	100	All Variables	95
Percent Minority Enrollment		Percent Minority Enrollment	
Percent Total Current Expenses for Transportation		Percent Students Eligible for ESEA, Title I Programs	
Local Fiscal Effort		Socioeconomic Variables	95
Average Salary of Teachers		Percent Minority Enrollment	
Socioeconomic Variables	100	Percent Students Eligible for ESEA, Title I Programs	
Percent Pupils from Low-income Families		Inschool Variables	70
Inschool Variables	100	Percent Staff with Advanced Degrees	
Percent Total Current Expenses for Transportation		Community Variables	75
Salary for Beginning Teachers		Student Mobility	
Average Administrator Salary			
Pupil-Administrator Ratio			
Percent Male Teachers			
Percent Certified Staff			
Percent Total Current Expenses for Instruction			
Pupil-Teacher Ratio			
Average Class Size			
Community Variables	92		
Local Fiscal Effort			
Population Mobility			
Size of School District			

In a sixth study Rose analyzed data from two additional states. Per pupil expenditures for total current expenses (1968-69) were related to mean district reading achievement raw scores to predict high and low productivity school districts.[7] Districts in State C falling more than two-thirds of a standard error above and below the regression line and in State D one standard error from the regression line were classified as high or low productivity districts. In State C the high productive group numbered twenty; in State D thirty-three districts belonged to this group. Sixteen districts in State D belonged to the low group, while thirty-two districts in State D belonged to this group. The four discriminant functions reported in Table 3 were developed for each state.

The seventh study identified fiscal characteristics associated with school district productivity in Georgia.[8] High and low productive districts were identified when the observed mean district achievement score on the verbal section of the Cognitive Abilities Test deviated from their predicted score by ± 1.33 standard errors of estimate or more, as predicted by the following variables:

1. Percent of students receiving free or reduced price school lunches.
2. Percent of families whose annual income equaled or exceeded $15,000.
3. Percent of students living with both parents.

Thirteen predictor variables reflecting fiscal characteristics were postulated as possible discriminators; the following two variables were statistically significant:

TABLE 3

MAXIMAL DISCRIMINANT FUNCTIONS, ROSE'S STUDY (1972)

STATE C	Percent Accurate Classification
All Variables	81
Median Adult Education Level Percent Pupils Eligible for ESEA, Title I Programs Percent Attendance	
Socioeconomic Variables	53
Percent Pupils Eligible for ESEA, Title I Programs	
Community Variables	72
Adult Education Level Percent of Attendance Local Fiscal Effort	
Inschool Variables	
No Function Possible	

STATE D	Percent Accurate Classification
All Variables	90
Percent Pupils from Families with Income Over $10,000 Percent Attendance Percent Pupils Entering Post-Secondary Educational Institutions Percent Teachers with Less Than Four Years of Preparation Percent Minority Enrollment Average Class Size Percent Staff with Advanced Degrees Pupil-Support Personnel Ratio	
Socioeconomic Variables	83
Percent Pupils from Families with Income Over $10,000 Percent Pupils Eligible for ESEA, Title I Programs	
Community Variables	84
Percent Pupils Entering Post-Secondary Educational Institutions Percent Attendance Percent Total Current Expenses for Instruction	

TABLE 3 (Continued)

STATE C	Percent Accurate Classification	STATE D	Percent Accurate Classification
		Inschool Variables	75
		Percent Total Current Expenses Disbursed for Instruction	
		Percent Staff with Advanced Degrees	
		Average Class Size	
		Percent Total Current Expenses for Transportation	
		Percent Teachers with Less Than Four Years of Preparation	
		Percent Teachers with More Than Twenty Years of Experience	
		Percent Teachers with Less Than Five Years of Experience	

1. Expenditure per pupil for instruction.
2. District size in ADA.

Sixty-eight percent of the districts were correctly classified.

Findings of the Studies

The findings of this group of studies indicate that certain administratively determined conditions are associated with varying levels of student productivity and that increased achievement might accrue to students in educational programs in which these conditions were present. Specifically, the results of the research emphasize once again the centrality of importance of teacher-related variables to educational achievement. Table 4 summarizes all of those predictor variables determined in this series of studies that are related to teaching staff. Whether defined in terms of years of experience, educational qualifications, or salary level, teacher variables may be described as the single most important group of factors manipulatable by school administrators. This research shows that consideration should be given to these variables related to teaching staff if the goal is to allocate school funds for optimal effectiveness.

Critique of the Studies

Cross-sample comparisons among the studies would have been facilitated if a uniform design had been used in each study. Different variables were regressed against achievement in each study, and different achievement measures were used in each study. A possible explanation of this deficiency is found in the lack of similarity of data bases among states and the absence of uniformity of output measures. Various socio-demographic data have become recently

TABLE 4

SUMMARY OF TEACHER PREPARATION AND
EXPERIENCE-RELATED PREDICTORS

Florida

1. Percent Teachers with < 2 Years of Experience
2. Percent Teachers with 7-14 Years of Experience

Delaware

1. Average Years of Experience of Teachers
2. Percent Teachers with Advanced Degrees
3. Percent Teachers without Degree
4. Beginning Salary for Teachers

Kentucky

1. Average Salary of Teachers
2. Percent Expense for Instruction
3. Percent Teachers with Advanced Degrees

City X

1. Percent Teachers without Degree
2. Mean Years Teaching Experience of Instructional Staff
3. Percent Expenses for Instruction
4. Percent Male Teachers

State A

1. Average Salary of Teachers
2. Salary of Beginning Teachers
3. Percent Expenses for Instruction
4. Pupil-Teacher Ratio
5. Percent Male Teachers

State B

1. Percent Staff with Advanced Degrees

State D

1. Percent Teachers without Degree
2. Average Class Size
3. Percent Staff with Advanced Degrees

Georgia

1. Expenditure Per Pupil for Instruction

available through the Bureau of the Census, but these constitute the only uniform data among states. Considerable similarity does exist in financial data, but each state still exercises considerable prerogative in format and assignment of expenditures.

The value of future comparison studies would be enhanced if a rigid discipline would be maintained in research design and choice of the initial variables. This series of studies suggests that the production function technique can be refined to improve upon the more simplistic simple regression methods formerly used. The initial separation of the school units under study into high and low productive groups is an improvement in the technique which may facilitate the identification of the most important variables associated with variations in educational productivity. While the results of the subsequent operations will be to some extent determined by the particular data elements available for study or the numerical form of variables, the extent of these deficiencies should be reduced with experience and the development of improved variable selection criteria.

Impact of the Studies

A major contribution in this series of studies was the testing of a procedural refinement in estimating the primary factors associated with variations in educational productivity among school districts. These procedures for estimating the relationships between certain factors influenced by administrators and the educational characteristics of students affected by these factors should enhance the objectivity of administrative decisionmaking.

Various elements of the relationship need to be explored in greater depth, but an obvious conclusion to be drawn from the available research is that a greater investment in teachers would have substantial impact on the educational achievement, however measured, of the nation's children. Of the several elements of the educational program which may contribute to educational productivity, those related to the teachers themselves appear to hold the greatest promise, both in terms of feasibility and potential impact.

NOTES

[1]The cost-quality studies completed before 1950 are reviewed by Paul R. Mort, W. C. Reusser, and J. W. Polley, Public School Finance, Second Edition (1951), and by Paul R. Mort in Problems and Issues in Public School Finance, ed. R. L. Johns and E. L. Morphet (1952). Studies completed between 1950 and 1960 are reviewed in the Third Edition (1960) of Public School Finance. W. E. Barron reviewed later studies in The Theory and Practice of School Finance, ed. W. E. Gauerke and J. Childress (1967).

[2]Bob N. Cage and Earl Blekking, "The Assessment of School District Productivity in the State of Florida," in Financing the Public Schools of Florida (Gainesville, Florida: National Educational Finance Project, 1973).

[3]Scott N. Rose, "Variables Associated with Local School District Productivity in Delaware," in Financing the Public Schools of Delaware (Gainesville, Florida: National Educational Finance Project, 1973), pp. 265-316.

[4]David DeRuzzo, "School District Productivity in Kentucky," in Financing the Public Schools of Kentucky (Gainesville, Florida: National Educational Finance Project, 1973), pp. 327-365.

[5]Carl J. Daeufer, "A Study to Identify Variables Which Predict Elementary School Productivity" (Ed.D. dissertation, University of Florida, 1972).

[6]David DeRuzzo, "Identification of Variables to Predict Local School District Productivity in Two States" (Ed.D. dissertation, University of Florida, 1972).

[7]Scott N. Rose, "A Study to Identify Variables to Predict Local School District Productivity in Two States" (Ed.D. dissertation, University of Florida, 1972).

[8]Carvin L. Brown, "Identification of Fiscal Characteristics Associated with Local School District Productivity in Georgia" (Ed.D. dissertation, University of Florida, 1974).